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Co-experience Network Dynamics: Lessons from the Dance Floor

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Abstract

Experience and socialization are key factors in determining customer commitment and renewal decisions in the service sector. To analyse the combined effect of experience and socialization, in this paper we introduce the concept of co-experience networks. A new methodological approach, originally applied in the field of social ethology, is devised to study reality-mined co-experience networks. By analysing a network of health club members over four years, we find that long-experienced clients have a lower chance to renew their contracts. On the other hand, central members in the co-experience network are stable and tend to renew their memberships. Further, since the members of the same reference group align their levels of commitment, renewal decisions are clustered in a small-world network. These findings contribute to our understanding of social dynamics and localized conformity in customer decision-making that can be used to plan marketing strategies to improve customer retention.

1. Introduction

Understanding the role of experience in individual and collective decision-making is crucial in a wide range of disciplines including social and political sciences, psychology, behavioral economics, design, marketing, and business. Research on customer behaviour reveals that

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individual choices are strongly influenced by information acquired from past experience (Fazio and Zanna 1981, Smith and Swinyard 1982, Fredrickson and Kahneman 1993, Branigan et al. 1997). Recent psychological studies shed new light on individual evaluation of past experiences, whether and how previous first-hand experience impacts behaviour, and how this issue can be exploited in real world settings (Fredrickson and Kahneman 1993). Past experience is also important in the service sector to design more effective marketing policies to retain customers. Previous literature widely investigates physical, spatial, and social aspects of experience (Buchenau and Suri 2000). Despite this, the nature of the relationship between a customer's prior experience and retention remains a fertile area of investigation in marketing research. Bolton (1998) demonstrates that individual decisions about future commitment are strongly influenced by previous experience. He found evidence that the higher the satisfaction, the longer individual experience, the higher the weight of prior assessment, and the lower the weight of new information of future decisions. Although advertising is important in favoring individual decisions of subscribing a contract or buying a product for the first time (Ganesh et al. 2000), renewal decisions are mainly influenced by prior experiences (Bolton et al. 2006). Bolton (1998) proposes an intertemporal-planning model through which satisfaction and experience influence individual behaviour, preferences, and choices. The model is based on an initial anchoring mechanism according to which individual decisions are influenced by satisfaction, followed by an adjustment process, for which decisions are updated by new pieces of information. The relationship between satisfaction of prior experiences and duration of the relationship is difficult to measure since both experience and information are socially mediated. Although a lot of attention has been devoted to the spread of information in social networks (Valente 1995, Valente 1996a, Valente 1996b, Valente 2005, Watts and Dodds 2007, Guimera et al. 2006, Aral et al. 2008) only few recent studies have investigated co-presence networks (Tokarchuk et al. 2009, Cattuto et al. 2010).

This paper contributes to fill this gap by developing a new methodological approach to study co-experience networks. In everyday life individuals have socially interactive experiences in their roles as consumers, workers, friends, or in general as members of groups and these experiences strongly influence their choices. Subjective experience is created in a dynamic social environment and is shared with other people through social contacts. Consequently, consumption decisions are shared with members of the same community (reference group) in social networks. In the last decade, research in marketing and design has stressed the importance of social context in evaluating individual experience. Recent studies investigate co-experience by examining how individual assessments are influenced by retrospective evaluations, shared situations and environments (Raghunathan and Corfman 2006, Ramanathan and McGill 2007). The increasing social complexity

of marketing environments has enhanced the interest of scholars in studying co-experience, defined as individual experience in an interactive context (Battarbee 2003b, Battarbee 2003a, Battarbee and Koskinen 2005, Bolton and Saxena-Iyer 2009). Indeed social networks modify the perception and evaluation of individual experience. Consequently, customer decision-making for joint consumption differs from self-experience (Ramanathan and McGill 2007). For example, the same choice leads to different decisions weather the customer lives an individual experience or a social one in an interactive context (Pine and Gilmore 1998, Forlizzi and Ford 2000, Battarbee and Koskinen 2005). Co-experience has also been investigated to design effective experience prototypes (Buchenau and Suri 2000, Battarbee 2003b, Battarbee 2003a, Ivey and Sanders 2006) and to increase customer retention by improving communicational tools and processes. Indeed, since customer retention is affected by social interactions, the impact of experience on renewals has to be contextualized. So the timing and the social context in which the experience and the renewal decisions take place are both important. Firstly, individuals who share experiences are subject to a “chameleon effect" according to which the longer subjects share the same environment, the higher the probability that subjects make aligned decisions and choices (Ramanathan and McGill 2007). Therefore, co-experience leads consumers to take similar decisions since they tend to align their opinions. Alignment of decisions is determined by *strong social ties* such as verbal and non-verbal communications as well as *weak social ties* such as co-presence, i.e. being at the same time in the same place with others (Zajonc 1965, Ramanathan and McGill 2007). Secondly, co-experience enhances individual arousal and pleasure, even more in case of alignment in decision among subjects. Ramanathan and McGill (2007) emphasize the “network value" of co-presence by revealing that the feeling of being connected to other people strongly influences individual evaluation, independently from the experience itself.

In this paper we introduce the notion of *co-experience network*. A co-experience network is a social network in which individuals repeatedly share the experience of specific situations in a given context. Co-worker networks of shared job activities, commuters using the same urban transport system and online communities of software developers are examples of co-experience networks. In a co-experience network two individuals are linked if they share some experiences. The more the experiences and the longer they share them, the stronger the link is. We develop an innovative methodology to study co-experience networks based on co-presence data. Traditionally, static social networks have been investigated based on questionnaire data and web-based social networking tools. More recently, thanks to the widespread diffusion of information and communication technologies (ICT), data on co-presence networks and weak social relationships have been collected and analysed both on-line and in real world settings (Ebel et al. 2002, Eagle and

Pentland 2006, Guimera et al. 2006, Eagle et al. 2009). Marketing experts, urban planning and transportation engineers increasingly rely on data on real-world social dynamics collected through reality mining tools to design products and solutions interactively (Graham 1997, Townsend 2000, Ratti et al. 2006, Rojas et al. 2008). We take advantage of a methodology originally developed by ethologists (Hinde 1976, Krause and Ruxton 2002, Whitehead 2008) to study the dynamic of social networks based on weak patterns of social interaction. Co-presence data are collected by means of radio-frequency identification (RFID) tags. In this study we consider co-presence as a mode that refers to all the circumstances, both spatial and temporal, during which people can reciprocally and instantaneously interact with each other (Zhao 2003). We analyse the dynamics of a co-experience network to test whether and how the renewal decisions are socially mediated. In particular, we are interested in analysing the determinants of the commitment to be a member of co-experience networks.

Our approach has important implications for customer relationship management (CRM) and strategy formation in the service sector (Priem 2007). CRM has already been widely applied to the service sector (Berry et al. 1983, Gummesson 1987, Gronroos 1990, Berry 1995, Gronroos 2002) taking advantage of data mining and RFID solutions (Schloter and Aghajan 2005, Lee et al. 2008, Ngai et al. 2008, Heim et al. 2009). By characterizing the real time dynamics of customer networks our methodological approach could be further exploited in the future to re-design co-experience networks for customer retention.

The paper is organized as follows. Section 2 describes the conceptual framework. Section 3 illustrates the methodology of co-presence network analysis and the empirical settings of our research. Section 4 discusses our main empirical findings. A concluding discussion section summarizes the results and explores future developments and potential applications of our methodology.

2. Conceptual Framework

The members of any community $M = \{1,2,...i,...m\}$ are connected by a network of shared experiences that we call co-experience network N. In a given time frame, each community member can be active or inactive within the network. A member of a health club is active when he does exercise at the gym. Similarly, a member of an online forum is active when he chats online. The more the active spells of two community members overlap, the more intense their relationship is in the co-experience network. Since on the basis of previous research it is found that decisions are based on previous experiences, we are interested in finding out whether and how individuals decide

to keep being a member of the community and how much time they want to spend as active members. We define D_i as the decision of individual i to belong to community M. The decision D_i can be either positive (+) or negative (-). The positive value of D_i (D_i^+) corresponds to the decision to renew the membership in the community, while (D_i^-) indicates an exit decision. We define $G_i \subset M$ to be the reference group of subject i. The reference group G_i represents i 's direct neighborhood in the network N. G_i is the group of members with whom subject i has stronger co-experience ties.

Decision-making models in networks (Watts 2002) assume that decisions are functions of the status of customer neighborhood. As introduced by Grabisch and Rusinowska (2008), each subject has an original inclination either to take or not to take an action, i.e. to renew or not to renew a contract. This individual inclination may differ from the final decision also because of other subjects' influences. So let $s_i \in R$ be a measure of the status or inclination of the customer i. In the simplest form the status of an individual can be either positive ($s_i = 1$) or negative ($s_i = 0$). The status of the reference group is the average of the status of all neighbors of node i in network N. If the status of the reference group is above a given threshold, the individual decision is positive. Furthermore, differently from what is found in social influence literature according to which the network is typically fixed, and the decision concerns some discrete exogenous choices, such as voting or buying a product, in our setting we are interested in finding out the activeness of members. Indeed, in this case each individual decides whether to be or not to be an active member of the community. By being active, an individual establishes new relationships in the co-experience network and influences other members' choices. When subject i enters the community at a given time *t* by signing a contract, we define $s_i^+(t)$ to be positive and equal to the duration of the contract. After the expiry date, s_i turns negative: in this case s_i^- specifies the time elapsed from the expiry of i 's contract. In general, a high value of s_i^+ is a signal of strong commitment, while a negative value of s_i^- corresponds to the decision to leave the network (negative commitment). To make sure that the status of the reference group is between 0 and 1 we normalize the positive status by dividing the duration of the contract by the maximum possible duration (a year). Similarly we divide the time elapsed from the contract expiry (negative status) by the maximum time gap between a contract expiry and the following renewal. Consequently we can define $s(G_i)$ as the state or inclination of the reference group of i in the co-experience network. So, the inclination of the neighborhood is defined as the average of the states of the reference group of customer *i* in the co-experience network. This variable measures the level of commitment of each subject's neighborhood.

By assuming that individuals have leisure-time constraints and preference for variety, we expect that a long experience in the community reduces the chances of membership renewal. Hence, workers should have a lower renewal probability since their leisure-time constraints are more stringent.

Proposition 1 *The longer the presence in a co-experience network and the more stringent the leisure-time constraint is, the higher the probability to leave the network is:*

$$if\ m_i > m_j\ then\ \Pr(D_i^-) > \Pr(D_j^-), \forall i, j \in N\ with\ i \neq j$$

where m_i *and* m_j *are the durations of the memberships and* $\Pr(D_i^-)$ *and* $\Pr(D_j^-)$ *are the probabilities of exit, of* i *and* j *respectively.*

The second aspect we are interested in is the relationship between duration and experience. By controlling for the duration of the membership, human interactions lead to a more positive evaluation of both the experience and the service (Ramanathan and McGill 2007, Moore et al. 2005). Moreover, a service environment that improves arousal and pleasure is likely to be more interesting for customers, who may stay longer in the store and renew service contracts. The importance of socialization for improving both loyalty and satisfaction of customers has been emphasized by Oliver (1999) through the concept of “village", and Baker highlights that a high socializing environment improves customer retention by favoring feelings of arousal and of willingness to buy products and renew contracts (Baker 1987, Baker et al. 1992). In the literature on network dynamics, preferential attachments and the “popularity is attractive” effect imply that the stability and the centrality of nodes are positively related (Barabasi et al. 2002, Jeong et al. 2003, Wagner and Leydesdorff 2005). Thus we expect that central nodes in the co-experience network have a higher probability of contract renewal.

Proposition 2 : *Central agents in the network have a higher persistence:*

$$If\ c_i > c_j\ then\ \Pr(D_i^-) < \Pr(D_j^-), \forall i, j \in N\ with\ i \neq j$$

where c_i *is the centrality of* i, c_j *is the centrality of* j *and* $\Pr(D_i^-)$ *and* $\Pr(D_j^-)$ *are the probabilities of exit of* i *and* j *respectively.*

Finally we are interested in verifying if the strength of the ties among individuals impact the alignment of renew decisions. Indeed since individual commitment and individual experiences are socially mediated, co-experience enhances alignment in decision-making processes. A “chameleon

effect" takes place when subjects share experiences. Witt (1969) found evidence of alignment in decisions by members of the same group: in particular, the higher the cohesiveness of the group, the higher the similarity of members' decisions.

Proposition 3 : *The level of commitment of subject i is positively related to the inclination of his neighbors,* $D_i^{\pm} = f(s(G_i)^{\pm})$, $\forall i \in N$. *More specifically, the stronger the ties between two subjects, the higher the probability that their decision to renew the contract or to exit the club will be aligned:*

$$\Pr(D_i^{+} \left| s(G_i^{+}) \right.) \geq \Pr(D_i^{+} \left| s(G_i^{-}) \right.),$$

$$\textit{and } \Pr(D_i^{-} \left| s(G_i^{-}) \right.) \geq \Pr(D_i^{-} \left| s(G_i^{+}) \right.), \forall i \in N .$$

In cases in which i and j are neighbors, we expect that the link between the subjects enhances their propensity of taking common action. In other words, we claim that co-experiences tend to align the level of commitment of each individual to that of his reference group. Different factors can be used as explanation for alignment in individual choices in co-experience environments. Alignment in decisions, evaluations, and willingness to both buy products and renew contracts are influenced by two atmospheric factors: ambient cues (common shared environment and co-experience) but also social cues (homophily and peer-effects) (Baker et al. 1992). These factors interact among each other and impact individual arousal and renewal decision. Therefore, within a social context, co-experience takes to alignment in decisions made by various subjects because of three main factors: contagion and peer-effects, homophily, and environmental effects.

First, individual decisions are often influenced by other people's choices. Because social networks play a role in many consumption and non-consumption decisions, peer-effects are crucial in order to determine whether and how individual decisions are influenced by friends' choices (contagion effect) and group decisions can be conditioned by opinion leaders and herd behavior (Bikhchandani et al. 1992, Banerjee 1992, Oh and Jeon 2007, Watts and Dodds 2007). Behavioral models explore how diverse patterns of social interactions have various impacts on individual choices, which are the result of not only direct changes in individual preferences but also indirect changes in the behavior of neighbors. More specifically, both the expectations and the preference orderings of a subject change according to the actions undertaken by neighboring subjects (Glaeser and Scheinkman 2003, Soetevent 2006). The tendency of subjects to act and decide according to the behavior of others is defined by Manski (1993) as endogenous interaction or peer-effect. Sacerdote (2001) demonstrates the strong impact of peer-effect on individual performance and decisions: he

finds that randomly assigned peers, for example roommates, are crucial in establishing individual academic performance and effort.

Second, alignment in decision making may be due to the similarity of tastes and attributes among subjects (homophily), rather than to endogenous peer-effects. These effects are not real social effects creating simultaneous interdependencies among subjects' actions (Soetevent 2006). Rather these are correlated effects according to which people may behave similarly because of similar individual characteristics and common exposure to the same institutional environment (Manski 1993). Also psychologists demonstrate that the higher the similarity among people, the higher the probability of attraction between them and the alignment in their behavior (Hampton and Wellman 2000, McPherson et al. 2003): individuals are more likely to choose to interact with more similar subjects. McPherson et al. (2003) highlight two types of homophily: in the first one (*status homophily*) similarity is due to socio-demographic characteristics, whereas in the second one (*value homophily*) similarity is due to attitudes and moral values. The homogeneity in the behavior of group members determined by the distribution of node characteristics is verified not only for close and strong ties, such as marriage (Kalmijn 1998), friendship (Verbrugge 1983), or work (Ibarra 1992), but also in all social contexts where interactions may take place (Wellman 1996, Mayhew et al. 1995, Hampton and Wellman 2000). The choice and tendency of subjects to interact with more similar subjects are also examined in Christakis and Fowler (2007) and in Christakis and Fowler (2008): the authors investigate features and dynamics of dyadic spread of obesity and smoking and find that the characteristics of both ties and nodes determine dynamics of the spread of obesity and individual decisions to stop smoking.

Finally, a stream of literature focused on the effect of store physical environment on individual attitudes, emotions, and choices (Mehrabian and Russell 1974, Donovan and Rossiter 1982, Baker 1987). Environmental influences are considered by Battarbee (2003a) uncontrollable factors impacting individual choices. Ambient cues are not only related to the atmospheric effects and to the physical features of the store environment, but also to the social interactions impacting individual attitudes and behavior. The distinction among these three effects will be discussed in more detail in the last section. In summary, by including the duration of the membership in the analyses (Proposition 1) we control for factors that can impact the effects of both sociality and experience of future commitment (Proposition 2-3) (Aral et al. 2009, La Fond and Neville 2010).

3. Data and Methodology

We test our model in the context of the health club service sector. This industry is rapidly growing in all high-income countries. In 2008 there were 122,473 clubs in the world with more than

117 million members and a total revenue of USD 68.2 billion (IHRSA 2009). The European market ranks first in the world with 46,736 clubs and 33.2 USD billion of revenues, followed by North America and Asia. Italy was the fourth largest national market after the United States, the UK, and Spain in terms of industry revenues (USD 4.4 billion) with 5.5 million members. In this study we analyse data provided by a health club in Tuscany, Italy. Our database includes comprehensive customer data and contract information for each member of the club from December 2004 to July 2008. Overall, the data consist of 4,649 codified individual members, 133,945 entry registrations, 103 contract types, and 4,892 subscriptions[2]. The club offers both traditional fitness programs as well as dance courses. More specifically, sixteen types of activities are available, including classical dance, belly dance, hip-hop, jiu jitzu, kick boxing, spinning, tai chun, yoga, and Latin American dances. We have classified contracts in terms of typology, duration, and cost. In addition to the standard contracts, the club uses other promotional tools that can influence both the renewal of the subscriptions and the recruitment of new customers (for instance, "holiday free" promotions, social dinners, and Facebook groups). Unlike Della Vigna and Malmendier (2006), our dataset does not contain renewal default, that is, there are no clauses for automatic renewal of the contracts.

The co-experience network includes 4,649 codified individual members, of which 4,378 have been observed in the health club at least once during the analysed period of 1,145 days (see Table 1).

[Insert Table1]

[Insert Figure1]

Figure 1 shows the strong seasonality of club attendance: entries are concentrated at the beginning of the week, remain stable from Monday to Friday, and drop during weekends and summer holidays. A similar trend is observed in all years. Based on an interview with the club owner, we know that the maximum presence is always well below the total capacity of the club. Moreover, the RFID system to monitor entries was put in place when the club opened in 2004 and consistently used up to 2008. Despite that, to avoid any potential problem of initialization and finite period truncation, we decided to limit our analysis to the three central years (2005-2007). The number of club members varies over time. Table 1 shows that in 2005 and 2007 the number of identified individuals was about 1,100, while in 2006 there was a sharp decrease of both total entries and active members. Thus, total turnover of club members was negative in 2006 and positive in 2005

[2] After grouping the contracts, based on the type of activity, we conducted the analyses on sixteen contractual categories. The rationale for grouping the contracts and the courses is based on the assumption that all participants in the same room have similar relationships. Moreover, the number of subscriptions is greater than the number of codified individual members because each member may have more than one contract. Specifically, the number of contracts for each individual ranges from 1 to 57.

and 2007. According to the owner, the downturn of active membership in 2006 is due to the opening of a new gym in the same area and the exit of one of the shareholders.

[Insert Table2]

The majority of club members (60 per cent) chooses a monthly subscription, while about one quarter of them subscribe to a yearly contract. As an example, Table 2 shows the duration, the number of subscriptions, the price, and the discount for the gym contracts, which represent 13 per cent of total subscriptions. The subscription fee is paid in advance by customers, and data show that for all the contract types the nominal price equals the effective price paid. The health club applies discounts, which are linearly related to contract length. Table 2 shows that, on average, a 3.6 per cent discount is applied for each month of contract duration (11 per cent for 3 months). Thus the same discount policy has been consistently applied to all customers throughout the period of time under investigation. By looking at course attendance and renewals, we note that most customers renewal decisions are taken immediately after the expiry of the contract and 90 per cent of the new contracts are subscribed within 40 days from previous contract termination. Therefore, the decision to leave the club, $D_i^-(t)$, is considered to be effective 40 days after the expiry of the contract.

To test our propositions we mapped three networks of relationships among club members:

1. *Exogenous social ties*: two individuals are linked by an exogenous social tie if they cohabitate or go to the club the first time together[3]. The data show that 1,649 subjects live together, while 2,493 subjects have no other club members reporting the same address.

2. *Induced social ties (group activities):* two subjects are linked if they choose to attend the same courses. The club management encourages socialization by scheduling group activities.

3. *Spontaneous social ties (co-experience):* two subjects have a co-experience tie if they are co-present in the club.

Our database includes 133,945 entries over the four-year period: the entries have been monitored through RFID systems. We define two individuals as entering together if the time gap between their entries is below a given threshold. Two subjects who frequently go to the club together are strongly

[3] In the interview the owner told us that among people who have exogenous social ties there are people that work together and attend the club during lunch breaks.

associated in the co-experience network: the less they go together to the club and the longer the elapsed time between two consecutive entries, the weaker the link between two individuals is in the co-experience network. Since the time cut-off is discretionary, we apply different thresholds (from 5 to 30 minutes) as a robustness check. In the first two networks a link is identified whenever two individuals live together or choose the same courses, even though they do not co-experience in the dance club.

The co-experience network is computed by applying a methodology currently used in social ethology (Whitehead 2008, Franks et al. 2009, Krause et al. 2009, Sih et al. 2009, Whitehead 2009). Two individuals are associated in a sampling period if the difference between the time of observation of co-presence is within a given time range. The association between two subjects is summarized by an association index, which is an estimation of the proportion of time that two individuals spend together. Among several measures of co-experience we selected the half-weight association index (a_{ij}), defined as:

$$a_{ij} = \frac{x}{x + y_{ij} + 1/2 \cdot (y_i + y_j)}$$

where x represents the number of sampling periods in which individuals i and j are jointly observed; y_i is the number of sampling periods when only i is identified; y_j is the number of sampling periods in which only j has been observed, and y_{ij} represents the number of times both i and j are identified but not together. This ratio is unbiased because each group has the same probability of being identified. Moreover, since each individual is registered as a member of the health club for only a small fraction of the sampling period, the half-weight index has to be applied to avoid biases in the computation of y_i, y_j, and x (Whitehead 2008). We replicated our analysis with different association indices and found that results are robust to the selection of alternative measures of association. Co-presence is not used to infer stronger social relationships (such as friendship) but rather to investigate the structure of weak ties, to measure co-experience, and to verify how stability and experience impact renewal decision.

By comparing the networks of cohabitants and shared activities in the club, we found that only 10.86 per cent of the co-habitants attend the same courses. This result can be easily explained by the different tastes of cohabitants: mothers and sons, fathers and daughters, wives and husbands presumably attend different courses. Moreover, the networks of co-habitants and co-experience (5

minutes cut-off) are largely independent: only 9.34 per cent[4] of the cohabitants go to the club together. Therefore, almost all the co-habitants attending the same courses enter together, but they are only a minority of total co-entrants. Since the network of co-presence in the health club is only weakly dependent upon exogenous social ties, we focus our analysis on the co-experience network.

[Insert Figure2]

Figure 2 shows a graphical representation of the co-experience network in 2008. To improve the legibility of the network we applied a 0.10 cutoff to the association index and set the size of each node proportional to its centrality (number of links). Nodes represent the members in 2008 for whom the data about contractual renewals are available: green nodes are members who renewed a contract in 2008, while red nodes represents those who did not renew. The network displays a small-world structure: clusters of highly connected nodes linked by few ties (Watts and Strogatz 1998). The majority of big central nodes are green nodes. At a first glance, this seems to confirm Proposition 2 according to which the central position of the subjects in the network is positively related to the decision to renew contracts. Moreover, the alignment in decision making described in the third proposition is also visually confirmed by the fact that green nodes and red nodes tend to be in the same cluster. By applying higher cutoffs we found that the resulting communities are even more homogeneous and formed by either green or red nodes. Finally, we shape as squares the nodes representing people attending the dance courses (the group at the bottom of the figure). They are the more central nodes and most of them form a separate and dense group. We can therefore conclude that renewal decisions tend to be shared at the level of local co-experience communities.

[Insert Table3]

The main structural properties of the co-experience network can be summarized by means of network statistics (see Table 3)[5]. The small values of clustering coefficient and eigenvalue centrality, which are both close to zero, are indexes of the sparseness of the network: individuals are associated only with few alters who may not associate with each other. Moreover individuals have either a low degree/strength or they are connected with members who have a low degree/strength. This result is confirmed by an analysis of affinity, which indicates the average strength of the

[4] This proportion remains stable and increases to 10.61 per cent if we consider, respectively, 10 or 15 minutes as the time distances on which associations are defined.

[5] The definitions of the network measures and indicators that will be introduced in this section are from Wasserman and Galaskiewicz (1994), Wasserman and Faust (1994), and Whitehead (2008).

adjacent nodes of a subject weighed by the association index between them. The average strength of neighbors is higher than the node strength due to the presence of some central nodes in most of the co-experience communities. The analysis of the reach index confirms that the network is heterogeneous and there are some subjects who have more strategic positions in contributing to their neighbors' evaluation of experience.

The average customer strength[6], i.e. the sum customer's association rates with other club members does not change significantly over time. Since all centrality indices are correlated, we decide to focus on the strength indicator in the following analyses. In our network the strength centrality is a measure of the number of times an individual goes to the club (experience) weighted by the number of co-present members (co-experience).

[Insert Figure3 and Figure4]

Figure 3, reports the strength connectivity distribution at the three different frequencies of entry in 2007. The connectivity distribution is relatively flat, and its skewness is negatively related to the length of the co-entrance time window (10-15 minutes): the longer the considered time window the flatter the distribution of the number of subjects according to their strength. The same trend characterizes all the other analysed years. Since the variance of the strength is limited, we expect a more prominent role of central subjects (Watts 2002). Figure 4 reports the probability distribution of entry and exit by node strength (co-entrance in a 5-minute time frame) and reveals that the majority of subjects entering or leaving the network have a lower level of strength centrality. Though there are cases in which subjects enter the network at the maximum level of strength as well as cases in which central members have left the network (in 2007, for instance, ten members with the highest levels of strength left the network). These preliminary findings seem to confirm the existence of a positive relationship between centrality and renewal decisions (Proposition 2).

4. Results

In this section we test how renewal decisions are influenced by the position of the club members in the co-experience network. We run a set of regressions to identify the variables affecting the renewal decisions (y_r) and, conditioned upon renewal, the duration of the renewed contract (y_d). y_r is a dummy variable (1 renewal and 0 otherwise), while y_d is the duration of the new subscription (in number of days). As discussed in the previous section, customers usually need

[6] Strength is applied in weighted networks to measure the degree of a node, that is, the number of links connected to the node in the network. This index is widely used in the literature to measure node centrality (Wasserman and Galaskiewicz 1994, Wasserman and Faust 1994, Whitehead 2008).

time to decide whether to renew the contract. Since the decision to exit is implicit, members cannot be classified by simply splitting them into those who renewed the contract and those who did not. Since our dataset does not contain renewal default, there are no clauses for automatic renewal of the contracts, we consider a non-renewal decision as effective only 40 days after the expiry of the contract.

The regressions are aimed at analysing how the probability of renewal is influenced by four groups of variables: individual's characteristics, learning and experience, the menu of activities offered by the health club, and co-experience network variables (Table 4).

[Insert Table4]

The following variables are used for characterizing individuals: *age* in years, a dummy for gender (1, male; 0, female), and a dummy for the employment status, *worker* (1, employed; 0, otherwise), which we use to identify those subjects who have a tight leisure time constraint. The dummy variable *immigrant* indicates whether subjects are Italian citizens (1, immigrant; 0, otherwise), and *log-distance* is the logarithm of the distance between the home address of each subject and the health club. Two variables are used for describing members' participation in the club: *duration* is the time in years of the club membership, and *attendance* is the frequency of attendance computed as the ratio between the number of effective entries of each subject in the club and the number of the total possible entries. Furthermore, p_{-1} represents the price of the last contract subscription by each member before the renewal decision, and it also serves as a proxy for the willingness to pay. The variable *time* is the moment in which the renewal decision is taken, and *delay* indicates the time elapsed from contract expiry. The two variables regarding the set of activities proposed by the club are the dummies *dance* (participation in dance courses) and *gym* ((individual use of exercise machines and gym equipment)[7]. We use only dance and gym dummies because these are the two most attended activities with 55 per cent and 13 per cent of total subscriptions, respectively. Finally, the network variables include both network indexes and neighbors' inclinations: *centrality* indicates the strength index of each individual, a measure of centrality in the co-experience network. *Neighbors* specifies $s(G_i)$, that is, the inclination of the neighbors of each subject and their level of commitment. As noted above, *neighbors* indicates if at the moment of contract renewal the reference group of the decision maker in the co-experience network is composed for the most part by people who have a long term commitment to go to the gym (positive values) or includes a majority of people who decided to leave (negative values).

[7] As explained in the previous section, members can choose among sixteen types of activities organized by the gym.

[Insert Table5]

The results of the regressions are reported in table 5. The second column summarizes probit regression results with the dummy y_r as the dependent variable[8]. Individual characteristics do not play a prominent role in renewal decisions, but the probability of renewal is influenced by socialization, experience, attendance, and kind of activities offered by the health club. More specifically, members' age has a positive and significant impact on the probability of renewal, while workers and females have a lower probability to renew. Indeed, the constraint of being a worker and, especially a young worker, reduces the flexibility, stability, and propensity to renew a contract. In contrast, the distance from the health club and the nationality of the members are not significant[9].

The duration of the membership (*duration*) has a negative effect on renewal decisions: the longer the membership in the club, the lower the probability of renewing. Therefore, a long affiliation to the club decreases the positive impact of experience on renewal decisions. This result, together with the negative sign of the *worker* dummy, confirms Proposition 1. On the other hand, *attendance* exerts a positive effect on y_r: the higher the attendance frequency of each subject, the higher the probability to renew the contract. This positive impact of individual experience on renewal decision confirms the first hypothesis in Bolton et al. (2006), according to which favorable (unfavorable) outcomes experienced over prior time periods will positively (negatively) influence renewal decisions for service contracts. Also the price of the previous contract, p_{-1}, has a positive impact on the probability of renewal: subjects having a higher willingness to pay are more willing to renew contracts. Conversely the *time* dummy captures a decreasing probability of renewal, partially due to stiffer competition. The time elapsed from the contract expiry (*delay*) also has a negative effect: the later a subject decides to renew a contract, the lower the propensity to renew it. The core activities organized by the club have a positive and significant impact on the probability of renewal: both *dance* and *gym* are effective in inducing participants to renew the contracts.

Finally, all the co-experience network variables impact significantly the probability of renewal: more specifically, both *centrality* and *neighbors* have a positive and significant effect on the decision to renew. Thus, the more central a customer in the co-experience network, the lower the probability to leave the network. Further, since we control for the frequency of attendance, this variable controls for the socialization at the gym: the larger the group of people with whom a client

[8] As a robustness check we also run a set of logit regressions, without noticing any significant change in the results.

[9] The result about the significance of the distance may be biased by the fact that we do not consider the distance between the gym and the workplace.

co-experience a service is, the higher the probability of renewal is. Thus Proposition 2 is also verified. The state of the reference group in the co-experience network is also very important. A positive commitment of the reference group consistently has a positive and significant effect on the decision to renew the contract. This finding provides support for the statement in Proposition 3: customers tend to align their renewal decisions in co-experience networks.

When the renewal decision is taken, members have to decide the duration of the new contract. The last column in table 5 shows the results of an ordered probit regressions[10]. For the ordered probit we identify four thresholds in order to examine decisions on contractual duration: monthly, three months, annually or longer. This choice is due to the fact that the demand is higher for these types of contracts (Table 2). Two regressions are run in order to take into account the correlation of the variable p_{-1} with the variables *duration* and *attendance*. Also in this case, the decision about the duration of the renewed contract is not significantly influenced by the individual characteristics: only the variable *age* has a positive and significant effect on this decision.

In addition to the fact that *neighbors* and *centrality* impact positively on renewal decisions, these two variables also have a positive impact on the duration of the new contract. Members who are central in the co-experience network tend to subscribe long-term contracts. Furthermore, individuals tend to align the duration of the contract with the reference group in the co-experience network. The duration of the membership (*duration*) has a negative effect on contract duration (even if it is not significant at the 10 per cent level): therefore, members that have been in the club longer are more likely either to not renew the contract or, if they decide to renew, to subscribe to a short-term contract. *Attendance* has a positive effect even if this effect on the duration of the new contract is less significant ($p < 0.10$): therefore, the higher the attendance rate, the higher the propensity both to renew the contract and, in particular, to renew longer contracts.

The price of the previous contract, p_{-1}, when included, has a positive impact on the probability of choosing long contracts, while *time* and *delay* influence negatively this probability: the later a subject decides to renew a contract, the lower the propensity to renew a long-term contract. The longer a member waits after contract expiry, the less likely he will renew a long-term contract. The variables of the activities, *dance* and *gym*, have a positive and significant influence on the decision to subscribe to longer contract. Therefore, the decision to renew the contract and, more specifically, to renew long-term contracts, does not depend simply upon the socializing features of the activities, but rather on the type of activity and on how these activities are structured and organized. Successful activities' organization by the club are crucial to create, develop, and improve

[10] The different number of observations between the two cases in Table 5 depends upon the different variables considered and, in particular, on the different number of missing values.

socialization, experience, and retention. In conclusion, we find that experience and socialization are both important for customer retention.

5. Concluding Discussion

In this paper we introduce the notion of co-experience network and develop a methodology to analyse data on customer interactions collected by means of RFID tags or other reality mining devices. On-line communities have been increasingly investigated, but so far little attention has been devoted to the analysis of the dynamics of customer networks in real-world settings. To our knowledge, this is the first attempt to study the impact of co-experience networks on customer retention in the service sector. More in general, this paper contributes to the analysis of customer behavior in co-experience networks. By analysing a network of health club members over a period of almost four years we find that retention decreases with the duration of the membership. Leisure time constraints and preference for variety induce long experienced subjects to leave the community. However, active club members and especially the central clients in the co-experience network are more likely to renew their memberships and to subscribe long-term contracts. The longer a customer waits after the contract has expired, the less likely he will renew it. Moreover, by controlling for individual characteristics and contractual options, we find that the commitment to go to the club is socially mediated. Health club members tend to align their commitment to the socially related group of co-members. The innovative methodology used in this study can be further applied to customer and human resource management to design co-experience networks. Our preliminary results can be used to improve the allocation of the marketing efforts, for example, to better allocate the instructors in the co-experience network of the health club. Secondly, our results can be used to develop more efficient discount policies, which take into account not only the characteristics of the contracts, but also the interpersonal influence about renewal decisions. Indeed, CRM managers in the service sector already implement customer relationship strategies such as fidelity cards, “bring a friend" promotions, and special discounts on the subscription price. However, these strategies are not based on analyses of customer experience: the proposed results and methodology can be applied to improve marketing policies by developing and implementing personalized marketing actions based on customer roles and positions in the network.

This study is not without limitations. Further work is needed to better distinguish among the factors determining alignment in individual decisions. Within a social context, alignment in decisions made by various subjects may be due to contagion and peer-effects, homophily, or environmental effects. Subjects may behave similarly not because of real social effects (Manski 1993, Manski 2000, Sacerdote 2001, Soetevent 2006), but because of correlated effects, similar

individual tendencies and tastes, and involvement in similar environments. Aral et al. (2009) provide evidence that more than half of behavioral contagion is due to homophily rather than to peer-influence. Indeed, the homogeneity in the behavior of group members may be determined by the distribution of individual characteristics. By considering both status and value homophily, as suggested by McPherson et al. (2003), we provide evidence that in our case family tie and other socio-demographic characteristics - such as gender, age and provenience - are not causes of homophily. Nevertheless, we are aware that this is not enough to clearly distinguish between neighbors influence and homophily. In future work, we aim to apply a methodology proposed by Aral et al. (2009) and Becker and Ichino (2002), who use matched sample estimations for distinguishing peer-influence from homophily in co-experience networks.

References

Aral S., Brynjolfsson E., and Van Alstyne M. (2008), "Productivity Effects of Information Diffusion in Networks", SSRN Working paper, Available at SSRN: http://ssrn.com/abstract=987499.

Aral S., Muchnik L. and Sundararajan A. (2009), "Distinguishing Influence-based Contagion from Homophily-driven Diffusion in Dynamic Networks", *Proceedings of the National Academy of Sciences*, 106, 51, 21544-21549.

Baker J. (1987), "The Role of the Environment in Marketing Services: the Consumer Perspective" in *The Services Challenge: Integrating for Competitive Advantage, American Marketing Association*, Chicago, IL, 79-84.

Baker J., Grewal D. and Levy M. (1992), "An Experimental Approach to Making Retail Store Environmental Decisions", *Journal of retailing*, 68, 445-455.

Banerjee A. (1992), "A Simple Model of Herd Behavior", *The Quarterly Journal of Economics* 107, 3, 797-817.

Barabasi A., Jeong H., Neda Z., Ravasz E., Schubert A. and Vicsek T. (2002), "Evolution of the Social Network of Scientific Collaborations" in *Physica A: Statistical Mechanics and its Applications* 311, 3-4, 590-614.

Battarbee K. (2003a), "Co-experience: the Social User Experience", in *CHI'03 extended abstracts on Human factors in computing systems*, ACM, 730-731.

Battarbee K. (2003b), "Defining Co-experience", *Proceedings of the 2003 international conference on Designing pleasurable products and interfaces*, ACM, 109-113.

Battarbee K. and Koskinen I. (2005), "Co-experience: User Experience as Interaction", *CoDesign* 1, 1, 5-18.

Becker S. and Ichino A. (2002), "Estimation of Average Treatment Effects based on Propensity Scores", *The Stata Journal,* 2, 4, 358-377.

Berry L. (1995), "Relationship Marketing of Services Growing Interest, Emerging Perspectives", *Journal of the Academy of marketing science*, 23, 4, 236-245.

Berry L. et al. (1983), "Relationship Marketing, Emerging Perspectives on Services Marketing", *American Marketing Association*, Chicago, IL, 25-8.

Bikhchandani S., Hirshleifer D. and Welch I. (1992), "A Theory of Fads, Fashion, Custom, and Cultural Change as Informational Cascades", *Journal of Political Economy*, 100, 5, 992-1026.

Bolton R. (1998), "A Dynamic Model of the Duration of the Customer's Relationship with a Continuous Service Provider: the Role of Satisfaction", *Marketing Science*, 17, 1, 45-65.

Bolton R., Lemon K. and Bramlett M. (2006), "The Effect of Service Experiences over Time on a Supplier's Retention of Business Customers", *Management Science*, 52, 12, 1811-1823.

Bolton R. and Saxena-Iyer S. (2009), "Interactive Services: A Framework, Synthesis and Research Directions", *Journal of Interactive Marketing,* 23, 1, 91-104.

Branigan C., Moise J., Fredrickson B. and Kahneman D. (1997), "Peak (but not end) ANS Reactivity to Aversive Episodes Predicts Bracing for Anticipated Re-experience", *Society for Psychophysiological Research*, Cape Cod, MA .

Buchenau M. and Suri J. (2000), "Experience Prototyping", *Proceedings of the 3rd conference on Designing interactive systems: processes, practices, methods, and techniques*, ACM, 424-433.

Cattuto C., Van den Broeck W., Barrat A., Colizza V., Pinton J.F., et al. (2010), "Dynamics of Person-to-Person Interactions from Distributed RFID Sensor Networks". *PLoS ONE,* 5, 7: e11596, doi:10.1371/journal.pone.0011596.

Christakis N. and Fowler J. (2007), "The Spread of Obesity in a Large Social Network over 32 Years", *New England Journal of Medicine*, 357, 4, 370-379.

Christakis N. and Fowler J. (2008), "The Collective Dynamics of Smoking in a Large Social Network", *New England journal of medicine*, 358, 21, 2249-2258.

Della Vigna S. and Malmendier U. (2006), "Paying not to Go to the Gym", *American Economic Review,* 6, 3, 694-719.

Donovan R. and Rossiter J. (1982), "Store Atmosphere: an Environmental Psychology Approach", *Journal of Retailing*, 58, 1, 34-57.

Eagle N. and Pentland A. (2006), "Reality Mining: Sensing Complex Social Systems", *Personal and Ubiquitous Computing,* 10, 4, 255-268.

Eagle N., Pentland A. and Lazer D. (2009), "Inferring Friendship Network Structure by Using Mobile Phone Data", *Proceedings of the National Academy of Sciences*, 106, 36, 15274-15278.

Ebel H., Mielsch L. and Bornholdt S. (2002), "Scale-Free Topology of E-mail Networks", *Physical Review E*, 66, 3, 1-4.

Fazio R. and Zanna M. (1981), "Direct Experience and Attitude-Behavior Consistency", *Advances in experimental social psychology,* 14, 161-202.

Forlizzi J. and Ford S. (2000), "The Building Blocks of Experience: an Early Framework for Interaction Designers", in *Proceedings of the 3rd conference on Designing interactive systems: processes, practices, methods, and techniques*, ACM, 419-423.

Franks D., James R., Noble J. and Ruxton G. (2009), "A Foundation for Developing a Methodology for Social Network Sampling", *Behavioral Ecology and Sociobiology* , 63, 7, 1079-1088.

Fredrickson B. and Kahneman D. (1993), "Duration Neglect in Retrospective Evaluations of Affective Episodes", *Journal of Personality and Social Psychology*, 65, 1, 45-55.

Fruchterman T. and Reingold E. (1991), "Graph Drawing by Force-directed Placement", *Software: Practice and Experience,* 21, 11, 1129-1164.

Ganesh J., Arnold M. and Reynolds K. (2000), "Understanding the Customer Base of Service Providers: an Examination of the Differences between Switchers and Stayers", *Journal of Marketing*, 64, 3, 65-87.

Glaeser E. and Scheinkman J. (2003), "Non-Market Interactions, Advances in Economics and Econometrics: Theory and Applications", *Eighth World Congress*, 1, 339-369.

Grabisch M. and Rusinowska A. (2008), "A model of influence in a social network", *Theory and Decision,* pp. 1-28

Graham S. (1997), "Cities in the Real-Time Age: the Paradigm Challenge of Telecommunications to the Conception and Planning of Urban Space", *Environment and Planning A*, 29, 105-128.

Gronroos C. (1990), "Relationship Approach to Marketing in Service Contexts: the Marketing and Organizational Behavior Interface", *Journal of business research*, 20, 1, 3-11.

Gronroos C. (2002), "Quo Vadis, Marketing? Toward a Relationship Marketing Paradigm, *The Marketing Review*, 3,2, 129-146.

Guimera R., Danon L., Diaz-Guilera A., Giralt F. and Arenas A. (2006), "The Real Communication Network behind the Formal Chart: Community Structure in Organizations", *Journal of Economic Behavior & Organization,* 61, 4, 653-667.

Gummesson E. (1987), " The new marketing Developing long-term interactive relationships", *Long Range Planning*, 20, 4, 10-20.

Hampton K. and Wellma, B. (2000), "Examining community in the digital neighborhood: early results from Canadas wired suburb", *Digital cities,* 194-208.

Heim G., Wentworth Jr, W. and Peng X. (2009), "The Value to the Customer of RFID in Service Applications", *Decision Sciences,* 40, 3, 477-512.

Hinde R. (1976), "Interactions, Relationships and Social Structure", *Man*, 11, 1-17.

Ibarra H. (1992), "Homophily and Differential Returns: Sex Differences in Network Structure and Access in an Advertising Firm", *Administrative Science Quarterly*, 37, 3, 422-447.

IHRSA (2009), "IHRA's 2009 Global Report: the State of the Health Club Industry". Boston, Ma.

Ivey M. and Sanders E. (2006), "Designing a Physical Environment for Co-experience and Assessing Participant Use", presented at *Wonderground, Design Research Society International Conference 200*6, 1-35.

Jeong H., Neda Z. and Barabasi A. (2003), "Measuring Preferential Attachment in Evolving Networks", *Europhysics Letters*, 61, 4, 567-572.

Kalmijn M. (1998), "Intermarriage and Homogamy: Causes, Patterns, Trends", *Annual Review of Sociology*, 24,1.

Krause J. and Ruxton G. (2002), "Living in Groups", Oxford University Press.

Krause S., Mattner L., James R., Guttridge T., Corcoran M., Gruber S. and Krause J. (2009), "Social Network Analysis and Valid Markov Chain Monte Carlo Tests of Null Models", *Behavioral Ecology and Sociobiology*, 63, 7, 1089-1096.

La Fond T. and Neville J. (2010), "Randomization Tests for Distinguishing Social Influence and Homophily Effects", *Proceedings of the 19th international conference on World wide web*, ACM, 601-610.

Lee L., Fiedler K. and Smith J. (2008), "Radio Frequency Identification (RFID) Implementation in the Service Sector: A Customer-Facing Diffusion Model", *International Journal of Production Economics*, 112,2, 587-600.

Manski C. (1993), "Identification of Endogenous Social Effects: The Reflection Problem", *The Review of Economic Studies,* 531-542.

Manski, C. (2000), "Economic Analysis of Social Interactions", *The Journal of Economic Perspectives*, 115-136.

Mayhew B., McPherson M., Rotolo T. and Smith-Lovin L. (1995), "Sex and Ethnic Heterogeneity in Face-to-Face Groups in Public Places: an Ecological Perspective on Social Interaction", *Soc. Forces,* 74, 15-52.

McPherson M., Smith-Lovin L. and Cook J. (2003), "Birds of a Feather: Homophily in Social Networks", *Annual Review of Sociology*, 27, 415-444

Mehrabian A. and Russell J. (1974), "An approach to Environmental Psychology", MIT Press, ISBN: 0262130904

Moore R., Moore M. and Capella M. (2005), "The Impact of Customer-to-Customer Interactions in a High Personal Contact Service Setting", *Journal of Services Marketing*, 19, 7, 482-491.

Ngai E., Moon K., Riggins F. and Yi C. (2008), "RFID Research: An Academic Literature Review (1995-2005) and Future Research Directions", *International Journal of Production Economics*, 112, 2, 510-520.

Oh W. and Jeon S. (2007), "Membership Herding and Network Stability in the Open Source Community: The Ising Perspective", *Management science,* 53, 7, 1086-1101.

Oliver R. (1999), "Whence Consumer Loyalty?", *The Journal of Marketing*, 63, 33-44.

Pine B. and Gilmore J. (1998), "Welcome to the Experience Economy", *Harvard Business Review,* 76, 97-105.

Priem R. (2007), "A Consumer Perspective on Value Creation", *Academy of Management Review*, 32, 1, 219.

Raghunathan R. and Corfman K. (2006), "Is Happiness Shared Doubled and Sadness Shared Halved? Social Influence on Enjoyment of Hedonic Experiences", *Journal of Marketing Research,* 43, 3, 386-394.

Ramanathan S. and McGill A. (2007), "Consuming with Others: Social Influences on Moment to-Moment and Retrospective Evaluations of an Experience", *Journal of Consumer Research,* 34, 4, 506-524.

Ratti C., Williams S., Frenchman D. and Pulselli R. (2006), "Mobile Landscapes: Using Location Data from Cell Phones for Urban Analysis", *Environment and Planning B: Planning and Design*, 33, 5, 727.

Rojas F., Calabrese F., Krishnan S. and Ratti C. (2008), *Real Time Rome*, MIT SENSEable City Laboratory.

Sacerdote B. (2001), "Peer Effects with Random Assignment: Results for Dartmouth Roommates", *Quarterly Journal of Economics,* 116,2, 681-704.

Schloter P. and Aghajan H. (2005), "Wireless Rfid Networks for Real-Time Customer Relationship Management", *Embedded and Ubiquitous Computing*, 1069-1077.

Sih A., Hanser S. and McHugh K. (2009), "Social Network Theory: New Insights and Issues for Behavioral Ecologists", *Behavioral Ecology and Sociobiology*, 63, 7, 975-988.

Smith R. and Swinyard W. (1982), "Information Response Models: An Integrated Approach", *The Journal of Marketing*, 46, 1, 81-93.

Soetevent A. (2006), "Empirics of the Identification of Social Interactions; An Evaluation of the Approaches and Their Results", *Journal of Economic Surveys*, 20, 2, 193-228.

Tokarchuk L., Shoop K. and Ma A. (2009), "Using Co-Presence Communities to Enhance Social Recommendation, Wireless On-Demand Network Systems and Services", *WONS 2009, Sixth International Conference on IEEE*, 169-172.

Townsend A. (2000), "Life in the Real-Time City: Mobile Telephones and Urban Metabolism", *Journal of urban technology*, 7, 2, 85-104.

Valente T. (1995), "Network Models of the Diffusion of Innovations", Hampton Press, Cresskill, NJ.

Valente T. (1996a), "Network Models of the Diffusion of Innovations", *Computational & Mathematical Organization Theory*, 2, 2, 163-164.

Valente T. (1996b), "Social network thresholds in the diffusion of innovations", *Social Networks,* 18,1, 69-89.

Valente T. (2005), "Network models and methods for studying the diffusion of innovations", *Models and methods in social network analysis,* 98-116.

Valentini R. and Jordan, F. (2010), "CoSBiLab Graph: the Network Analysis Module of CoSBiLab", *Environmental Modelling & Software*, 25, 7, 886-888.

Verbrugge L. (1983), "A Research Note on Adult Friendship Contact: A Dyadic Perspective", *Social Forces*, 62, 1, 78-83.

Wagner C. and Leydesdorff L. (2005), "Network Structure, Self-Organization, and the Growth of International Collaboration in Science", *Research Policy,* 34,10, 1608-1618.

Wasserman S. and Faust K. (1994), "Social Network Analysis: Methods and Applications", Cambridge University Press.

Wasserman S. and Galaskiewicz J. (1994), "Advances in Social Network Analysis: Research in the Social and Behavioral Sciences", Sage Publications, Inc.

Watts D. (2002), "A Simple Model of Global Cascades on Random Networks", *Proceedings of the National Academy of Sciences of the United States of America*, 99, 9, 5766–5771.

Watts D. and Dodds P. (2007), "Influentials, Networks, and Public Opinion Formation", *Journal of Consumer Research*, 34, 4, 441-458.

Watts D. and Strogatz S. (1998), "Collective Dynamics of Small-World Networks", *Nature,* 393, 6684, 440-442.

Wellma, B. (1996), "For a Social Network Analysis of Computer Networks: a Sociological Perspective on Collaborative Work and Virtual Community", *Proceedings of the 1996 ACM SIGCPR/SIGMIS conference on Computer personnel research*, ACM, p. 11.

Whitehead H. (2008), "Analyzing Animal Societies: Quantitative Methods for Vertebrate Social Analysis", University of Chicago Press.

Whitehead H. (2009), "SOCPROG Programs: Analysing Animal Social Structures", *Behavioral Ecology and Sociobiology*, 63, 5, 765-778.

Witt R. (1969), "Informal Social Group Influence on Consumer Brand Choice", *Journal of Marketing Research*, 6, 4, 473-476.

Zajonc R. (1965), "Social facilitation", *Science*, 149, 3681, 269-274.

Zhao S. (2003), "Toward a Taxonomy of Copresence", *Presence: Teleoperators & Virtual Environments*, 12, 5, 445-455.

Tables

Table 1: Summary statistics of the complete dataset

	2004	2005	2006	2007	2008	2004-2008
Number of days	12	315	312	316	190	1,14
Number of individuals	370	1,157	866	1,090	895	4,37
Number of entries	915	33,295	26,503	38,199	35,033	133,94

Table 2: Duration, number of subscriptions, price, and discount rate for the main products

Duration (months)	Subscriptions	Price (Euro)	Discount (%)
1	664	75	-
3	257	200	11
6	102	350	22
12	605	500	44

Table 3: Summary Network Statistics

	Minutes	2005	2006	2007
Average Strength $c_i = \sum_j a_{ij}$	5	1.71 (1.23)	1.40 (0.92)	1.79 (1.22)
	10	3.40 (2.44)	2.77 (1.79)	3.31 (2.23)
	15	5.19 (3.67)	4.22 (2.68)	4.88 (3.27)
Average Eigenvalue Centrality $e_i = (\text{ first eigenvector of a })_i$	5	0.01 (0.03)	0.02 (0.03)	0.02 (0.02)
	10	0.01 (0.03)	0.02 (0.03)	0.02 (0.02)
	15	0.02 (0.02)	0.02 (0.03)	0.02 (0.02)
Average Reach $r_i \sum_j a_{ij} \cdot c_j$	5	4.46 (4.22)	2.81 (2.35)	4.67 (3.97)
	10	17.56 (16.48)	10.86 (9.06)	15.89 (13.30)
	15	40.42 (36.67)	24.95 (20.15)	34.54 (28.53)
Average Clustering Coefficient $cc_{ij} = \frac{\sum_j \sum_k a_{ij} \cdot a_{ik} \cdot a_{jk}}{\max(a_{jk}) \cdot \sum_j \sum_k a_{ij} \cdot a_{ik}}$	5	0.03 (0.03)	0.03 (0.05)	0.03 (0.06)
	10	0.04 (0.03)	0.04 (0.04)	0.04 (0.07)
	15	0.05 (0.04)	0.05 (0.04)	0.05 (0.06)
Average Affinity $f_i = r_i / C_i$	5	2.33 (0.67)	1.85 (0.46)	2.41 (0.58)
	10	4.55 (1.28)	3.60 (0.90)	4.39 (1.04)
	15	6.86 (1.88)	5.39(1.29)	6.44 (1.48)

Notes: Standard errors in parentheses

Table 4: Summary statistics

	Mean	**Std.Dev.**	**Min**	**Max**
y_r	0.678	0.467	0	1
y_d	89.031	145.358	0	1,692
age	25.810	14.396	5	72
gender	0.379	0.485	0	1
worker	0.360	0.480	0	1
immigrant	0.027	0.174	0	1
log-distance	1.196	1.221	-3.611	6.812
duration	0.099	0.147	0	1.291
attendance	0.072	0.182	0	5.566
p_{-1}	50.049	115.254	0	900
time	2.147	0.848	0.016	4.816
delay	-0.043	0.251	-3.819	0.997
dance	0.086	0.280	0	1
gym	0.187	0.390	0	1
neighbors	0.053	0.464	-3.488	0.997
centrality	3.367	1.622	1	8.722

Table 5: Regression results

	Probit	**Ordered Probit**	
	y_r	y_d	y_d
age	0.007***	0.003**	0.004**
	(0.002)	(0.001)	(0.001)
gender	0.141**	0.040	0.056
	(0.071)	(0.044)	(0.044)
worker	-0.209***	-0.048	-0.037
	(0.074)	(0.045)	(0.045)
immigrant	-0.172	-0.102	-0.129
	(0.210)	(0.128)	(0.129)
log-distance	0.015	0.011	0.021
	(0.027)	(0.017)	(0.017)
duration	-2.233***	-	-0.001
	(0.318)	-	(0.150)
attendance	9.466***	-	0.160*
	(1.050)	-	(0.093)
p_{-1}	0.007***	0.003***	-
	(0.001)	(0.000)	-
time	-0.820***	-0.652***	-0.655***
	(0.045)	(0.029)	(0.029)
delay	-0.416***	-1.339***	-1.194***
	(0.125)	(0.080)	(0.076)
dance	2.597***	1.224***	1.309***
	(0.351)	(0.086)	(0.087)
gym	1.480***	0.976***	1.426***
	(0.248)	(0.055)	(0.054)
neighbors	0.607***	0.260**	0.335***
	(0.200)	(0.125)	(0.124)
centrality	0.243***	0.138***	0.163***
	(0.027)	(0.015)	(0.016)
N. observations	3,269	3,297	3,278
Pseudo R^2	63.74%	25.76%	21.65%

Notes: Standard errors in parentheses. *Significant at the 10-per cent level. **Significant at the 5-per cent level. ***Significant at the 1-per cent level.

Figures

Figure 1: Daily number of entries in 2005

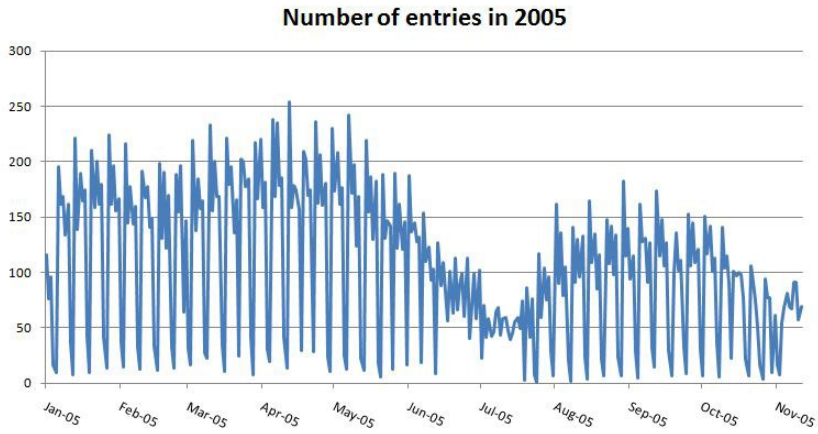

Figure 2: Co-presence network in 2008

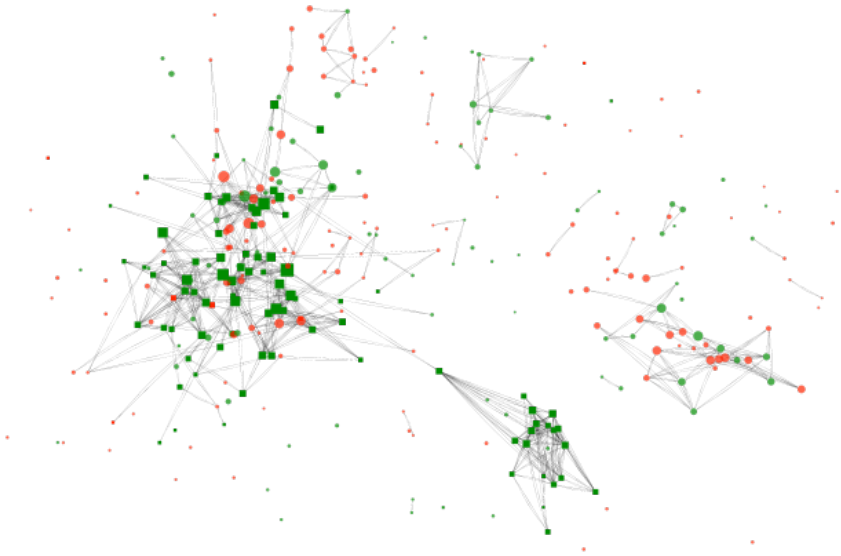

Figure 3: Connectivity distribution in 2007

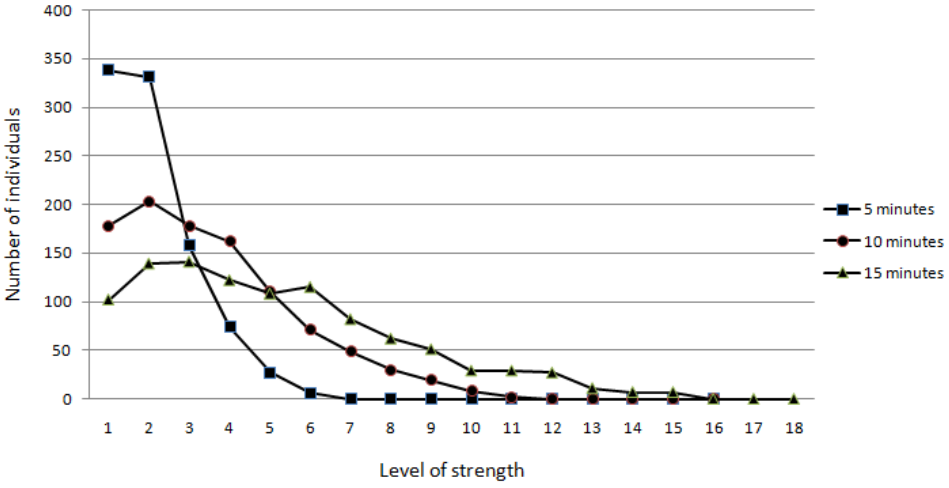

Figure 4: Entry and exit probability distribution by node strength (5 min)